Invited Talk

Discrete Differential Forms and Applications to Surface Tiling

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The geometry of manifolds has been extensively studied for centuries — though almost exclusively from a differential point of view. Unfortunately, well-established theoretical geometric foundations do not directly translate to discrete meshes: discretizations of inherently-continuous notions such as curvatures and geodesics may lose their geometric and/or variational properties.

In this talk, we will introduce the notion of discrete differential forms and show how they provide differential, yet readily discretizable computational foundations [1]. We will describe how key geometric properties built into their description can more readily yield robust numerical computations which are true to the underlying continuous equations: they exactly preserve invariants of continuous models in the discrete computational realm.

These discrete forms will be put to good use, first for surface flows and conformal parameterizations, then for the design of pure quadrilateral tiling of arbitrary 2-manifolds [2]. We will also briefly mention other applications (fluid animation, vector field design) benefiting greatly from this principled, discrete approach to geometry and computations.

[1] Mathieu Desbrun, Eva Kanso, Yiying Tong, *Discrete Differential Forms for Computational Modeling,* in ACM SIGGRAPH '05/'06 Course Notes of Discrete Differential Geometry.

[2] Yiying Tong, Pierre Alliez, David Cohen-Steiner, Mathieu Desbrun, *Designing Quadrangulations with Discrete Harmonic Forms,* Preprint (2006).

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